

Life in a Slum: understanding living conditions in Nairobi's slums across time and space.

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Abstract: This paper overviews the role of slums in urban Africa, focusing on Nairobi. It reveals the characteristics of slums and how these have changed over time. Spatially disaggregated data show that slum areas are very dense with poor-quality buildings, lacking access to key services such as sewage disposal and electricity. However, improvements to building quality, public-service provision, and socio-economic characteristics are mostly outpacing those seen in the formal sector. Measures such as child health and school attendance have caught up or are on pace to catch up in the near future with the formal sector, while improvements in building quality and service provision are advancing more slowly. We find significant heterogeneity across the city, and in particular that central slums look to be 'stuck' with low-quality buildings and poor service provision, though not with low socio-economic indicators. We explore potential explanations for why slums located on highly prized land near the centre may be stuck with poor infrastructure.

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I. Introduction

Countries across Africa are currently in a period of rapid urbanisation, with urban populations growing by an average 3.55 per cent per year (UN World Cities Report 2016). Kenya and its capital Nairobi are no exception; the rapid growth of the city, increasing from 2 million people to 3.1 million in the ten years between 1999 and 2009¹, is drawing attention to how the city can accommodate the millions of expected new residents. These new urban residents need housing, and if formal housing is underprovided many could end up living in slums. Already 56 per cent of the urban population in Kenya are living in slums, an increase from 33 per cent in Nairobi forty years ago (Lall et al. 2017 p.38)². A similar pattern is repeated across the continent, and while

¹ Authors' calculation

² This number is comparable across others within the same report. However, as noted in Section II below, multiple definitions of slums exist. In our analysis of Nairobi, we observe a smaller share of the urban population living in slums, as we use a tighter definition.

this issue is not unique to Africa, these numbers are far above the 34 per cent of the urban population living in slums in Latin America and South Asia. As the process of urbanisation continues, both the role of slums in African cities and the conditions for those living in slums become increasingly important issues for policymakers.

In this paper we outline stylised facts about slums in Nairobi, revealing how their characteristics vary according to both location and time. In doing so, we are able to highlight the relative conditions for those living in slums compared to both formal and rural areas. We provide descriptive analysis of who lives in slum areas, the living conditions they face, and the access they have to jobs, healthcare and education. We analyse how these vary by location and how these have changed over time to highlight the dimensions along which slums are improving or deteriorating. Together, these provide a better understanding of living conditions in slums today, and the priorities for policymakers preparing for increasing slum populations over the coming decades.

(i) How to conceptualize slums?

Slums are hard to define. While UN-Habitat and others have tried to establish a standard definition (an area where households lack at least one of the following: access to improved water, access to improved sanitation, sufficient living area, durability of housing, or security of tenure), the reality is that the local context matters and different countries adopt their own definitions. By their very nature slum areas are also likely to change quickly, as the low cost housing is simple to build, demolish or improve. As a result, there are few studies that look at the dynamics of slum areas within cities, or at the characteristics of slums across cities. Data limitations typically prevent comparisons over both time and space. In this paper, due to the availability of detailed census data at two points in time, we are able to focus on the evolution of slums within one city.

Many of the productivity benefits that exist in cities result from their density: within a relatively short travel time, firms can access a wide set of potential employees and consumers, and households can buy goods and services from a large choice of firms. The average population density of slums in Nairobi was 28,200 people per km² in 2009, 51 per cent higher than just 10 years previously and far higher than in formal residential areas. These slums could therefore potentially be an efficient use of urban land providing high-density, low-

cost accommodation near other households and near markets. However there are also many reasons why slums may be an inefficient use of prime urban land. First, with low-quality one- or two-storey buildings and little public transport provision, their density leads to crowdedness. This both decreases liveability within slum areas and limits accessibility, reducing the potential benefits that density provides. Residents have little access to urban areas beyond the slum in which they live, leading to low mobility and preventing residents from accessing jobs and educational opportunities elsewhere within the urban area (Salon and Guylani, 2010). Second, dense areas are also subject to large externalities across households. Gollin *et al.* (2017) report higher crime rates in highly dense areas, and the risk of transmission of communicable diseases increases (Sclar *et al.* 2005). These externalities are worsened if there is underinvestment in services, with a lack of access to clean water and sanitation in particular having large negative health consequences; for example Duflo *et al.* (2012) report that 88 per cent of diarrhoea infections are attributable to poor sanitary infrastructure, unsafe hygiene procedures, and a lack of clean water. Finally, underinvestment in private living conditions also affects life quality. Cattaneo *et al.* (2009) show substantial impacts on child health from replacing dirt floors with cement floors and also find positive effects on adult well-being measures.

Most of these potential negative impacts of slums stem from underinvestment, both in private and public services. Low levels of investment in slum areas may arise for multiple reasons. It may simply be that households have a low willingness to pay for services. However, for many services such as water and sewage systems, installation costs are high and require coordination among users to pay for the investment or state provision. In addition, if land rights are weak and the owner or renter is uncertain that they will hold the rights to their building in the future, the incentive to invest in the local environment is reduced. Land market failures may also lead to the land being inefficiently allocated to those who may not value it the most. Finally, there may be political and economic reasons why the political elite have no incentive to improve living conditions within slums. As a result, local poverty traps could form, where residents are unable to benefit from the opportunities of the city (Marx, Stoker, and Suri, 2013).

(ii) Our investigation

Using detailed spatially disaggregated census data from Nairobi, we draw out stylized facts on who lives in slums, their wealth, the quality of buildings, the access to services, and child health and education outcomes. We examine how these may vary across both space and time within the city and compared to rural areas. The data is a repeated cross-section of individuals, so we cannot track people over time. We can however track the characteristics of neighbourhoods within the city, revealing how those living in slum areas differ, and how their living conditions are changing.

Slums are incredibly dense areas, with those near the city centre approximately ten times as dense as formal residential areas in the part of the city. Visually, this density combined with poor quality buildings give an appearance of neighbourhoods stuck in poverty. Households are smaller and the number of rooms per person lower than in formal areas. Access to services including improved water supplies and sewage disposal are both very low, alongside ownership of assets. Along other dimensions however, the picture is not as stark, particularly when we observe the changes over time. First, while housing quality and access to water and sanitation services is worse than in formal areas, it is significantly better than in rural areas. Second, there is some catch-up in housing quality between slum and formal areas over time, concentrated however in more distant slums. Third, in terms of access to electricity, as well as schooling and child mortality, the improvements seen over the last decade have resulted in slum households catching up with the levels seen for households in formal areas just ten years previously. Slum areas are not static areas of poor living conditions, but instead are areas that are experiencing dramatic changes. Identifying both why these changes are occurring only in some dimensions and how these changes can be supported are key questions for research and policy to address.

Section II outlines the context of our analysis, including why Nairobi can inform policy-makers working on cities across the region, and the specifics in the history of Nairobi which may have influenced its slums. How we measure slum characteristics—adult demographics, private investment in building quality, public investment in services, and health and educational outcomes for children—and their changes over time and space is discussed in section III. We highlight the main empirical difficulties in a study of this kind. Section

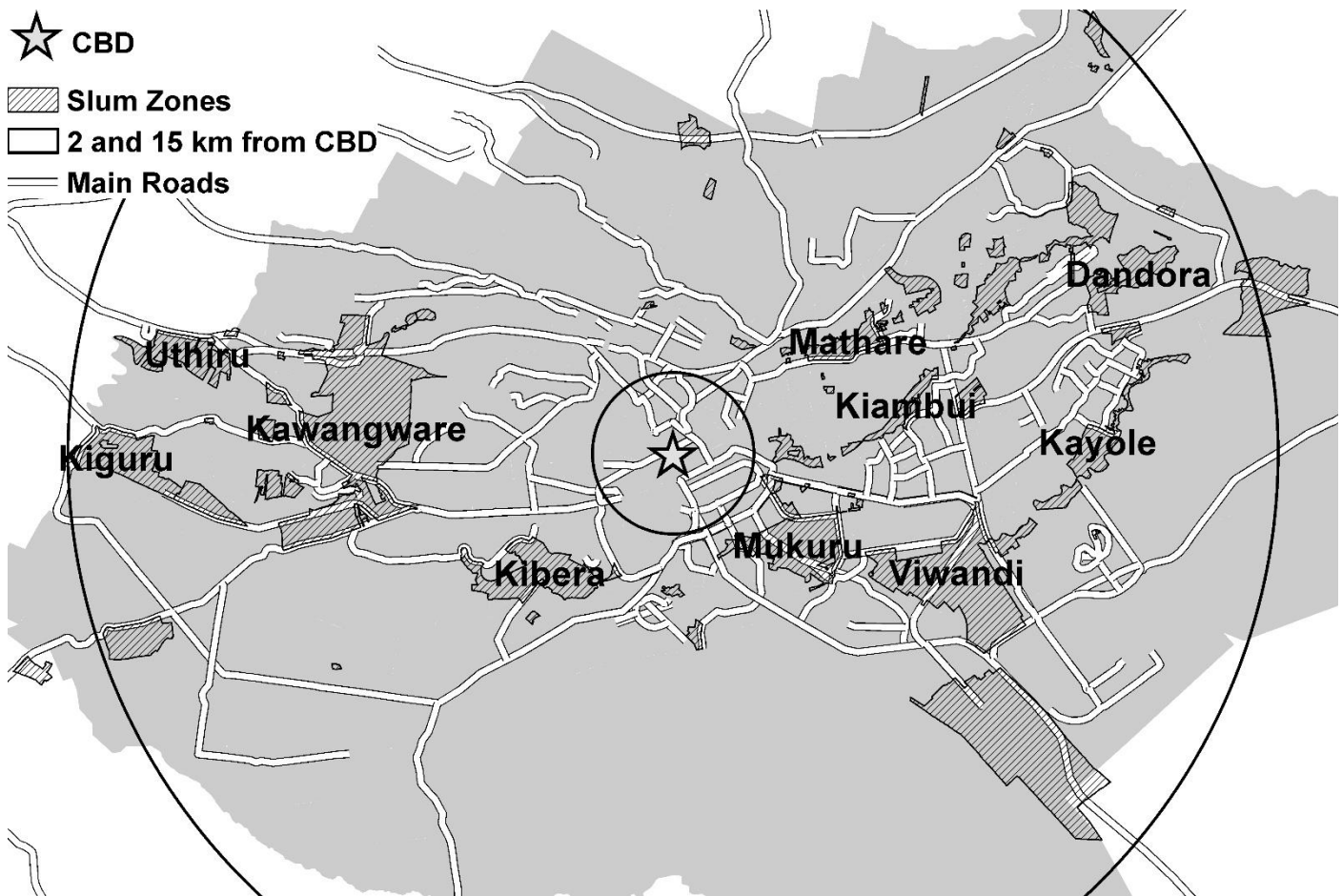
IV then draws out stylized facts from Nairobi that address the issues outlined above. In section V, we discuss how these issues are relevant to policy-makers, before concluding.

II. Nairobi context

Nairobi is home to over 3m people, including 180,000 in perhaps the most well-known of African slums, Kibera, which is located just a few kilometres from the centre. Numerous other slums spread throughout the city, as shown in Figure 1, varying among other things in size, density, access to the centre, access to main arterial roads, and land rights.

Our analysis is conducted using repeated cross-sectional data on individuals using the 1999 and 2009 population censuses, giving a 10 per cent sample of the city. Over this ten year period, Kenya and Nairobi experienced major changes. First, national GDP grew quickly, at an average rate of 3.8 per cent a year (Feenstra *et al.*, 2015). Second, the urban population grew simultaneously, increasing by 50 per cent in the same period. The rapid growth of Nairobi is not however the complete story of the city over this time period. It was also a decade of upheaval, some of which was focused specifically in slum areas. A wave of violence in Nairobi's slums following the 2007 elections may have some influence on the outcomes that we study. This period of violence was hardly an unprecedented random shock, as Cheeseman (2008) notes, citing severe ethnic conflicts in the early and mid-1990s. We do not attempt to disentangle the effect of this violence from other channels that may have affected changes in slums. If slums are, for example, more prone to politically induced ethnic violence, the impact of this on slum outcomes is included within our results. We are able to document changes in slum conditions, but further work is required to reveal the mechanisms behind these.

Figure 1: Location of major slums in Nairobi, relatively to the Central Business District (CBD)



Since change depends on the institutional and legal situation in slums areas, as well as the characteristics of these areas and their location relative to urban markets, the legal and institutional complexities of Nairobi are worth exploring. First, the legal ownership of land in slums is frequently under dispute. The example of Kibera illustrates how convoluted claims on property rights can be reinforced over time and potentially trap slums into areas with little investment. At the turn of the twentieth century, the British Colonial government enrolled Sudanese soldiers to serve in the King's African Rifles and fight for the British. These Nubian soldiers were granted permission to settle on the land that is now Kibera, and in spite of some pressure for them to leave, in 1950 they were granted official permission to stay. After Kenyan independence however, the government revoked all Nubian claims to land in Kibera. Finally, a motion to provide the Nubians with land titles was passed in parliament, although the government continued to ignore their claim and the motion was never implemented (Joireman and Vanderpoel, 2011). Currently the Nubians in Kibera continue to live on land that is formally considered property of the government, but over which they argue they have a legal claim. In addition to the Nubian settlers, since independence in 1964 migrants have flooded into Kibera, all settling without official government recognition. These settlements are facilitated by local chiefs who are government representatives but have no authority to grant land titles. The chiefs take payments for the construction of

structures and allow the builders to act as landlords (Joireman and Vanderpoel, 2011). As a result, the decision today of who should be granted titles, or how to allocate compensation for evicted residents, are matters of dispute.

Second, in addition to legal complexities, misplaced incentives in the government can further distort the development process of slums. There is a long history in Kenya of government corruption pertaining to the use of land. Seminal work by Klopp (2000) argues that in the 1990s the Moi government was losing influence due to the decline of traditional forms of patronage, greater international scrutiny of corruption, and more political competition. In response, the government increasingly used the allocation of public land as a form of patronage. In 2004, a report headed by Paul Ndungu was published, researching the unlawful allocation of public lands under the previous administrations. Southall (2005) summarizes the findings in the Ndungu Commission's report, noting that, on urban land specifically, there was found to have been widespread abuse of presidential discretion in making land grants to individuals for political reasons, without consideration to the public interest and without proper pursuit of legal procedures, including outright illegal allocation. Given the context of public land allocation in Kenya, it is not hard to believe that slums on public land in Nairobi are being used as a means of patronage, and governmental power is abused for private gains.

Finally, in Nairobi, slum dwellers are not simply squatters, they pay rent to slum landlords even if the land is not owned privately. In a survey of 1,755 Nairobi slum households in 2004, Gulyani and Talukdar (2008) found that 92 per cent were rent-paying tenants and only 6 per cent own both the land and structure. Furthermore, they estimated very short payback periods on housing investment in slums, highlighting the high costs to tenants of living in slums relative to the housing value. Such high returns to the landlords are often indicative of high entry barriers, which in Nairobi include the need for political connections, the payment of significant illegal fees, and a willingness to bear the risk of demolition and loss of capital. These slum landlords obtain security of their investment through political mechanisms, which are obtained despite the absence of formal legality, enabling a process that Amis (1984) calls the 'commercialization' of shanty towns. Specifically, a survey of landlords in Kibera by Syagga, Mitullah, and Karirah-Gitau reveals that many are government officials and politicians (as cited in Gulyani and Talukdar (2008)).

III. Empirical strategy

The analysis conducted in this paper uses individual and household level data from a repeated cross-section. Households and individuals in the 1999 and 2009 population censuses are grouped into comparable geographical units, enumeration areas (EAs), which are identified as slum or formal. We look at the association between various demographic characteristics and child health and education at the individual level, as well as housing, assets and access to services at the household level, with whether or not that individual

(household) is in a slum area. We conduct analysis using the individual level (household level) using OLS³ as follows:

$$Y_i = \alpha + \beta * D_i^{Slum} + \gamma * D_i^{2009} + \delta * D_i^{Slum \& 2009} + \theta * X_i + \varepsilon_i$$

where Y_i is the outcome variable of interest for the individual (or household), typically a binary variable, such as whether or not a household has a solid stone or brick wall, although sometimes it can be a continuous variable, such as the child mortality rate. On the right-hand side, D_i^{Slum} , D_i^{2009} , and $D_i^{Slum \& 2009}$ are dummy variables signifying respectively if the individual (household) lives in a slum or not, if the year of the observation is 2009, and if the individual (household) lives in a slum and the year is 2009. This allows us to separate the general trends in outcomes across the whole city over time, as well as the incremental changes felt only within slum areas. The marginal effects from these estimations are plotted, along with the 5 per cent critical values to show the different means of the outcome variable concerned in slum and formal areas and in 1999 and 2009. Standard errors are clustered at the EA level. The average levels for these outcome variables in rural areas are also plotted for comparison.

We are also interested in how the correlation between living in a slum and our outcomes varies according to other characteristics. This can be captured using controls, X_i , which may include other characteristics of the individual, such as education level, and other characteristics of the area, such as distance to the city centre or land ownership of the plot. However the inclusion of these controls leads to no substantial differences in the results. We allow therefore for a more general analysis, interacting the right-hand-side variables D_i^{Slum} , D_i^{2009} , and $D_i^{Slum \& 2009}$ with distance to the city centre, distance to the nearest industrial site, tenure status of the household, and individual slum identifiers. This captures heterogeneous relationships between slums and living conditions across space, tenure status and slums. We discuss the results for all of these except distance to the industrial site, as there is little variation of interest along this dimension.

It is important to note here that the estimated coefficients show correlations: are people who live in slums faced with worse buildings, services, and social outcomes? They do not capture a causal impact of slums on these outcome variables, as the presence of sorting of households across areas within the city means that many, if not all, of our outcome variables are endogenous.

(i) Issues and approach

There are inherently several major issues faced when analysing slums. First, there is no standard definition of slums, and different governments, non-governmental organizations (NGOs), and other bodies may all define slums differently. This paper uses a static definition of slum boundaries in Nairobi provided by the Kenya National Bureau of Statistics (KNBS) and created in 2009 as an indicator for informal settlements. From

³ We also estimate the same analysis using probit estimations to check that we have similar results. Because our key explanatory variables are binary and, for simplicity, we prefer the OLS estimations, we are in effect just estimating the sample means.

conversations with employees at the KNBS, EAs are defined as slum if they are ‘unplanned’. Other slum definitions are available for Nairobi, including a mapping by the Center for Sustainable Urban Development (CSUD) at Columbia University as part of a 2004 land-use map (see Williams and Klopp (2014) for their full methodology) and another by IPE Global Private Limited and Silverwind Consultants (2013) under the Kenya Informal Settlements programme. Although the criteria for these alternate definitions are similar, the lack of a coordinated effort to map slums through time has resulted in inconsistent mapping. For comparable measures across cities, greater conformity is required.

Second, very little quality data on slums in Africa exists. Surveys can provide very detailed measurement of outcomes in slums, however are both time-intensive and costly to run, which often limits their extent both across time and space. Another source of potential data is census data, which is what we use in this paper. This has two main advantages. Census data captures the full population of an urban area, perhaps with 10 per cent surveyed in greater detail, allowing comparisons across different areas within the city. Population censuses are also typically repeated regularly, allowing comparison of the same areas of cities over decades. However, while the full population is in theory recorded, it is often difficult to gain access to the data at a fine level of spatial disaggregation. When data are grouped into large administrative units, much of the variation in access and land ownership patterns is lost. The questions are also less exhaustive than in surveys, and less tailored to the economic questions concerned. There is also a growing literature that attempts to circumvent the difficulties posed by a lack of conventional data in slums. For instance, satellite imagery has been used in a variety of ways to measure otherwise intractable aspects of slums and other fine-scale areas in developing country cities. Marx *et al.* (2016) use a series of very high-resolution satellite images to measure the brightness of tin roofs in a slum as a proxy for household investment, and Henderson *et al.* (2016) use digital tracings from aerial imagery to measure built volume across the whole of Nairobi.

The third source of difficulties in assessing the development of slums is understanding the population being referred to. Over time, residents move in and out of any given area within a city. These movements may be in response to the conditions they are facing. First, the current residents of slums have selected into those areas. For example, a correlation between whether somebody lives in a slum area and the wage they earn may show that slum dwellers earn lower wages than other city residents. However, care must be taken to ensure that this is not attributed as a *causal effect*. The slum may provide lower access to jobs compared to other neighbourhoods, but the slum also attracts those who do not have a high paying job owing to cheaper rents. Any analysis of slums has to be aware of this sorting across neighbourhoods, and ensure that the differences between slum and non-slum populations are not attributed uniquely to the conditions in slums. Second, when using repeated cross-section data where individuals cannot be traced over time, the movement of households is lost. For example, if a slum area provides interim housing for new arrivals in a city, then when households successfully land a decent job and save up enough money, they may move on and settle in a different neighbourhood. If this were repeated, with a new arrival replacing them in the slum area, the characteristics

of those who live in slums would appear to be static over time. Those who benefit from slums then move on and no longer appear in the cross-sectional data as slum residents. The slum conditions are such that there are positive benefits for these people that would not be captured by this analysis. The analysis in this paper is only comparing conditions within slums themselves over time, and against formal areas.

(ii) Data

This paper makes use of publicly available microdata from the Kenya Population and Housing Censuses for 1999 and 2009. The data is two repeated cross-sections at 10-year intervals, with the location of households recorded at the EA level, of which there are over 4,000 in the city, a level of precision rarely available to researchers. In general, the spatial extent that we examine is the administrative area of Nairobi County, which stays constant from 1999 to 2009. For our analysis along the distance to centre, we restrict focus to EAs within 2–15km from the city centre so that each kilometre bin contains at least 100 slum households and 100 formal households. We are limited by the questions the census records. For example, data on the type of job residents perform are limited, and information on water provision is coded differently in the two periods, preventing comparisons over time.

The KNBS slum definition assigns 2009 EAs as slums or not, and we are then able to classify 1999 EAs as slum or not depending on their spatial relation to the 2009 EAs. For our main set of results, we classify 1999 EAs as slums if at least half of their total area intersects a 2009 slum⁴. We run robustness checks using a range of different cut-offs and find similar results. Holding the slum area constant over time ensures we are comparing the same areas in the analysis. However, it does ignore the fact that some new slum areas may have emerged or, indeed, disappeared between the two time periods. New slums potentially have different characteristics, and are not captured in this analysis.

Figure 2 shows the location of slums within Nairobi, alongside the 1999 EAs.

Figure 2: Slums and EAs in Nairobi

⁴ A complication that arose in mapping the census data spatially was in producing maps for the 1999 census. Previously, the highest spatial resolution available for mapping census data in Nairobi was to the 110 sub-locations (SL) in the city. Since many spatial characteristics, including slums, of urban areas manifest at a finer scale, much of the heterogeneity in the data would then be lost. In order to overcome this difficulty, we photographed the original hand-drawn census enumeration maps from the KNBS archives in Nairobi, a total of 194 maps which detail all EAs and some households in Nairobi from the 1999 Kenya Census. We digitized the boundaries and identifier numbers of all 4,636 EAs. After the digitization process, the census microdata were readily merged, allowing us to give highly precise locations of each surveyed household based on their EA identifier.



IV. Stylized facts

1. Who lives in slums?

- (a) *Slums have population densities up to ten times higher than in nearby formal areas.*
- (b) *Slum residents are more likely to be male and living in smaller households than those in formal areas. This is particularly true near the city centre.*
- (c) *While slum residents are less well educated than the rest of the city's population, their level of education has increased over time.*
- (d) *Slum residents are more likely to be in paid jobs, particularly if they live near the centre; this falls off sharply in neighbourhoods further from the centre.*

Slums are spread throughout the city of Nairobi, as shown in Figure 3 below. Most of the city's slum residents live within 3km and 12km of the centre, with few at the very heart of the city. One of the most striking features of slums is their dense living conditions and in Figure 4 we document the population density in slum and formal areas by distance to the CBD. The differences are large: between 3km and 6km from the centre, slums are approximately 10 times as dense as similarly located formal areas with a population density averaging over 60,000 people per km².

Figure 3: Location of residents relative to CBD

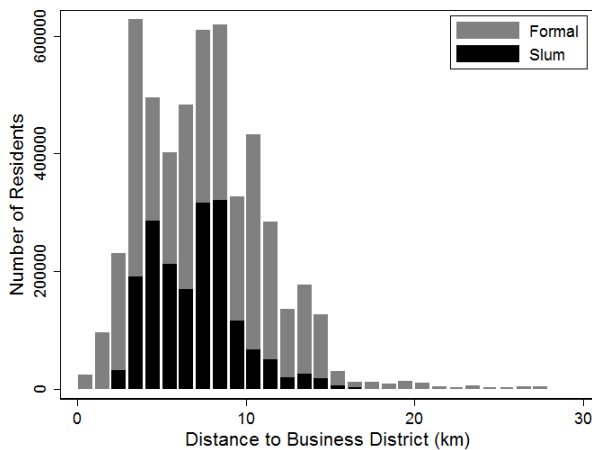
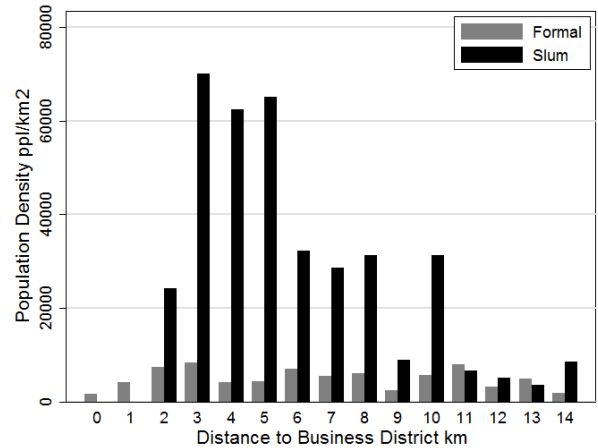


Figure 4: Population density across formal and informal areas, by distance to CBD



In Figure 5 we plot the sample means of population and household characteristics across slum and formal areas. Just 43 per cent of those living in slums are female, an increase from 1999 but still below the natural average of 50 per cent. In Figure 6, we observe how this varies by the location of the slum. Nearly 60 per cent of adults living in slums near the city centre are male, a reduction from 1999 but still far above the natural average. An equal male/female ratio is only reached at 12km from the centre. Within formal areas, the male/female ratio does not vary by distance to the CBD. Households in slums are also smaller than in formal

areas, with 2.9 people per household compared to 3.4. Again, Figure 6 shows how this differs by distance to the CBD. In formal areas, households are slightly larger near the urban core; however in slum areas, central households are approximately 20 per cent smaller than their less central counterparts.

We also note that those living in slums have lower levels of education. The adult population has a 51 per cent rate of some secondary education in 2009 compared to over 71 per cent in formal areas. This share has however increased rapidly over the preceding decade, by 11 percentage points in slum areas and 14 percentage points in formal areas. This compares to an increase of just 3 percentage points in rural areas, where the secondary education rate is just 12 per cent in 2009. This shows that the adult population in slum areas is dynamic; either new, higher educated people are moving in over time, or the previously resident population is becoming increasingly educated. Figure 6 shows that this increase in education happened in slums throughout the city except on the fringes, indicating that the effects are not due to sorting of individuals across slums, for example through the higher-educated relocating into better slums.

We also show that slum residents are slightly more likely to work for pay than those in formal areas, although the difference is small, at five percentage points. This is particularly the case for those located near the city centre, where approximately 50 per cent of slum residents work for pay, falling to 35 per cent near the fringes of the city. This large decline highlights the importance of residential location; central slums offer better access to paid jobs, and those living in more distant slums have a decreased chance of working in paid employment. Unfortunately, more detailed data on the types of jobs performed are unavailable.

Together, these facts show slums to be dense areas with predominantly male populations living in small households. While education levels are lower than the citywide average, adults in slums are becoming increasingly well-educated over time and those nearest the city centre are more likely to be accessing paid jobs. These facts support a story male family members being sent to the city to find work and earn money, living in small households near to urban labour markets. However, in Figure 5 we also show that, of those not born in the same district, those living in slums in 2009 have been there on average 8 years. While slightly less than in formal areas, this shows that the location decisions are not temporary. Men move into slums and remain there; they benefit from access to urban jobs and education, but we cannot rule out that they are stuck in these areas of urban poverty.

Figure 5: Adult population characteristics in slum and formal areas

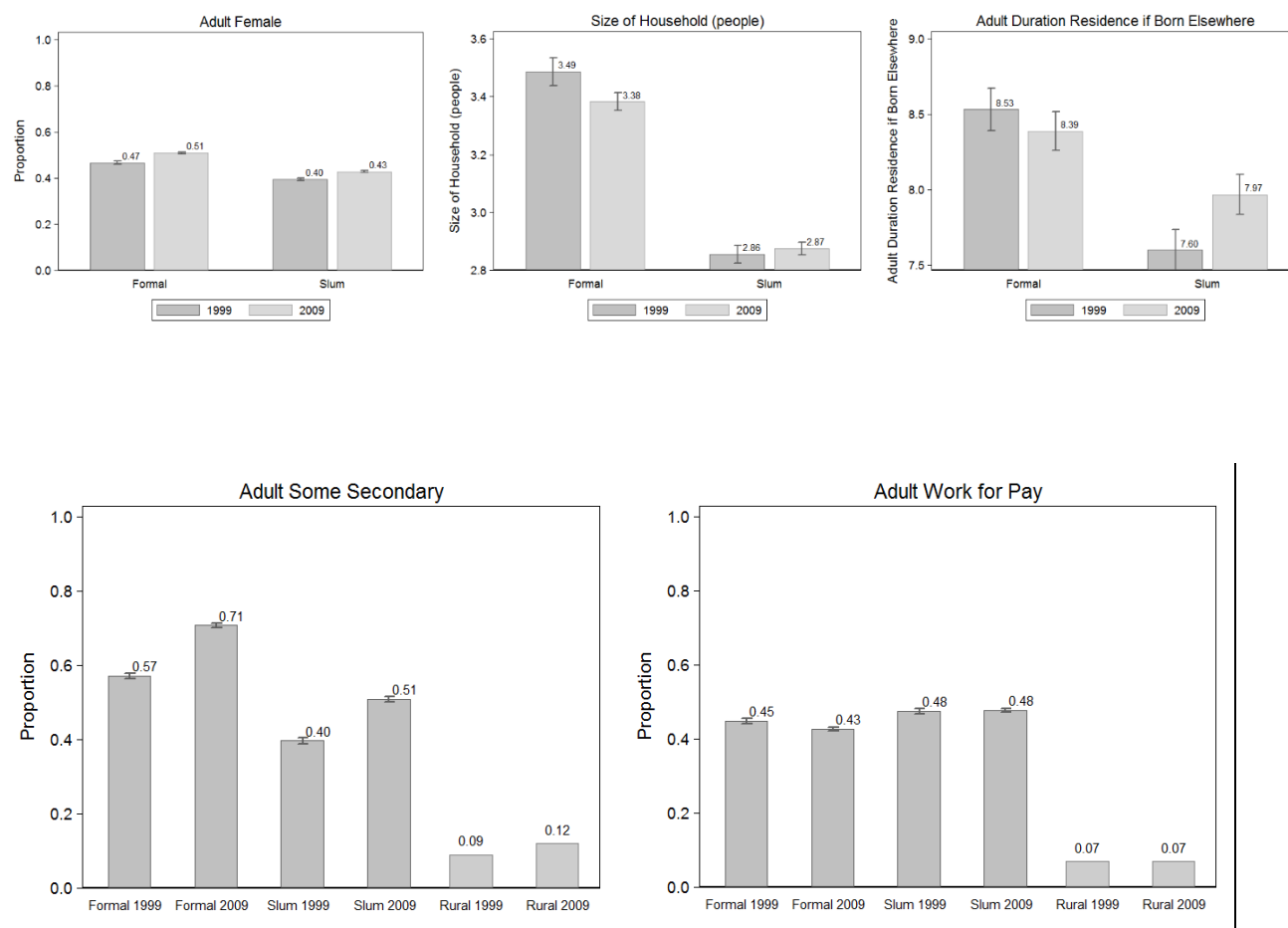
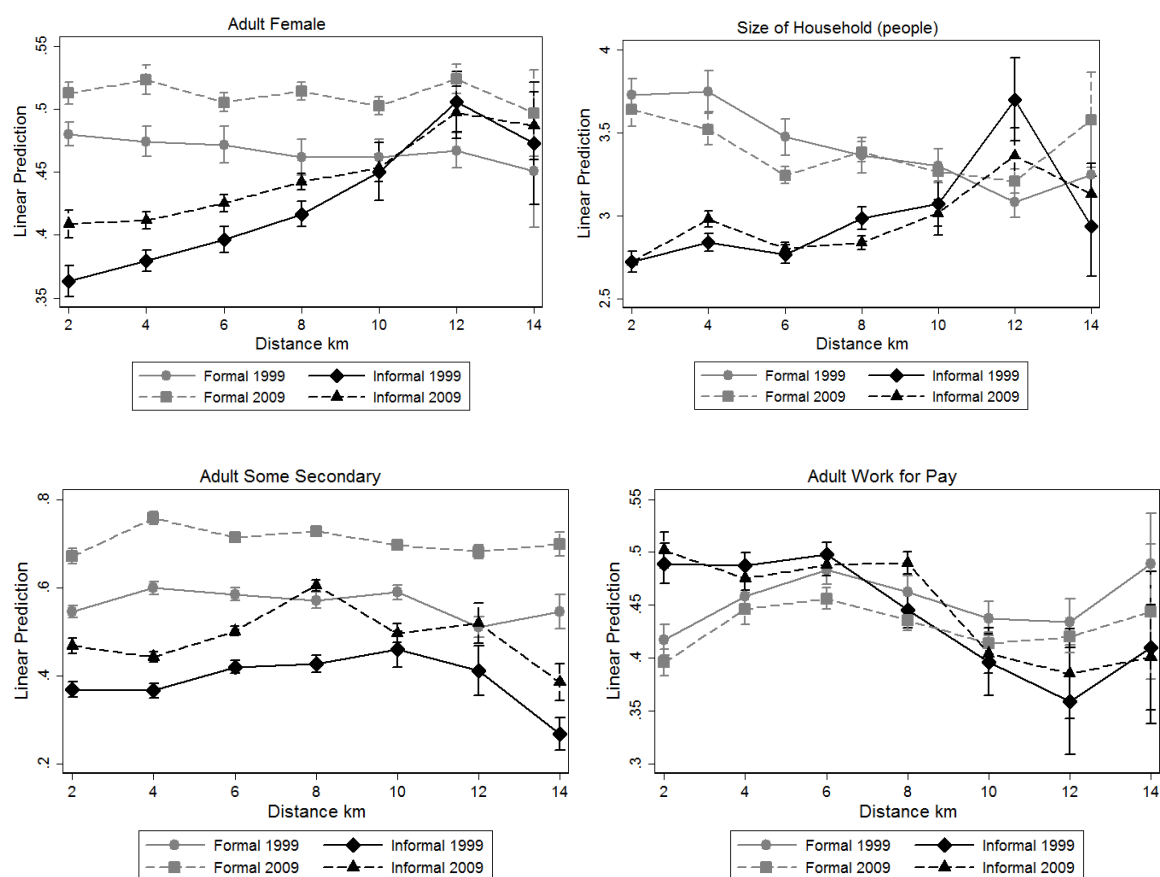


Figure 6: Population characteristics by distance to CBD, in slum and formal areas



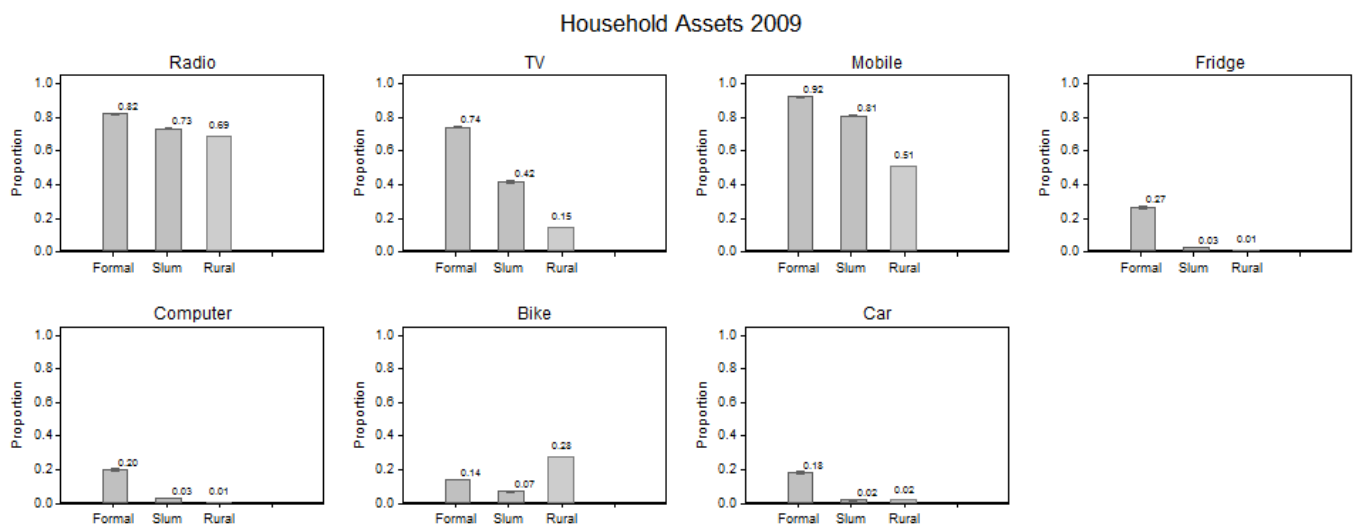
Note: Marginal effects of being in a slum or formal area in 1999 or 2009, estimated using OLS over 2km bins, with 95 per cent confidence intervals and errors clustered at the EA level.

2. How wealthy are slum residents?

- (a) *Material wealth, as proxied by household goods ownership, is lower in slum households than in formal households, but still higher than in rural areas.*
- (b) *Centrally located slum households are materially poorer than more distant neighbourhoods, suggesting a trade-off between rents and asset ownership. In contrast centrally located formal households are materially richer than more distant neighbourhoods.*

Figure 7 show the levels of asset ownership at a household level in slums and formal areas, estimated using OLS, and the mean levels of ownership in rural areas for comparison. These data were only collected in 2009 so we cannot observe how asset wealth has changed since 1999. Lower levels of asset ownership are observed across the board in slum areas versus formal areas, and particularly for televisions, fridges and computers, all of which require a steady electricity supply. Compared to rural areas, however, households in slums have high rates of household good ownership. The only exception is bicycles which tend to be more common in rural areas where they may complement rural living or substitute for poor public transport. Despite the poverty in slums, those living in these urban areas can better afford these material goods compared to their rural counterparts.

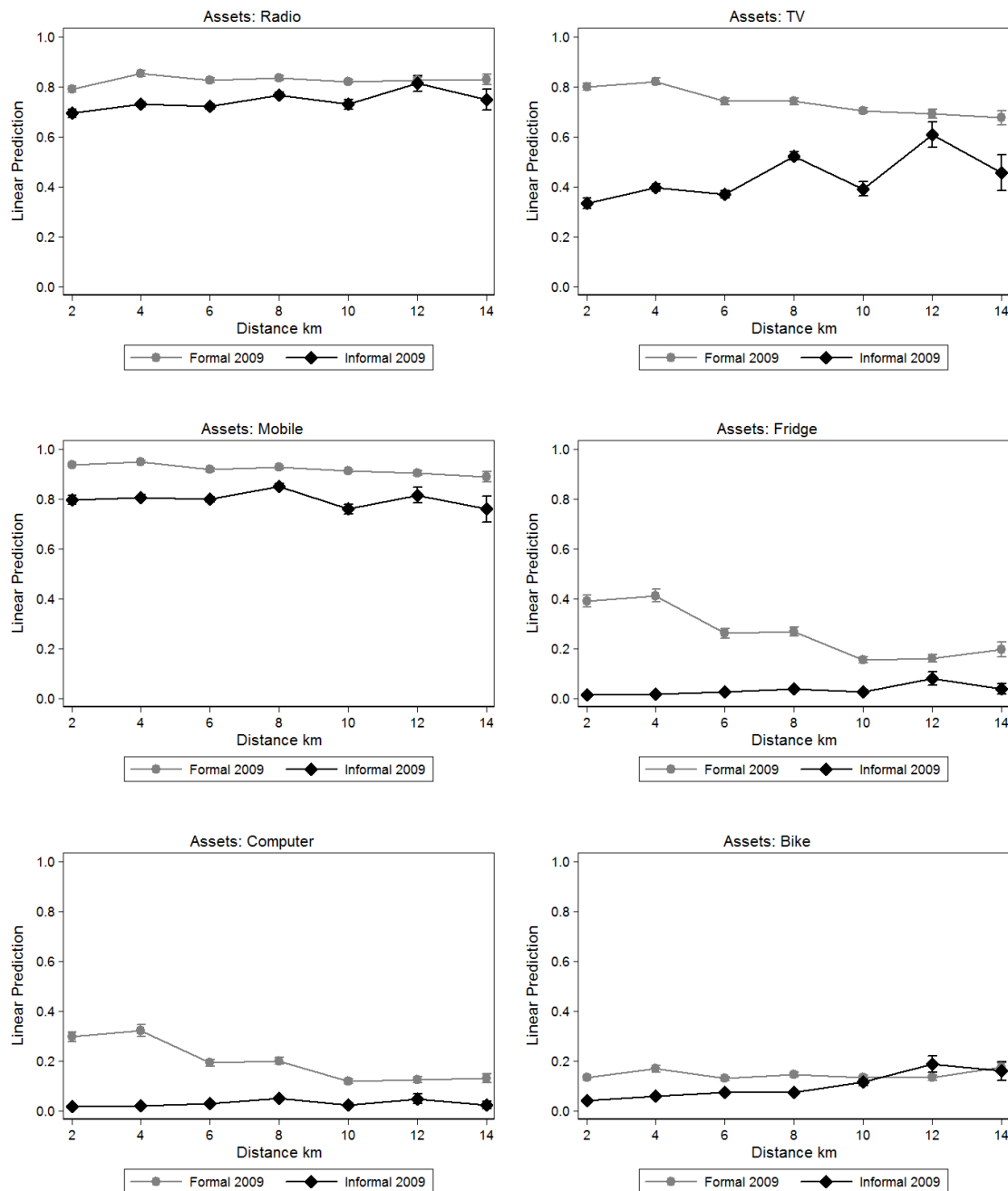
Figure 7: Household asset ownership in slum and formal areas

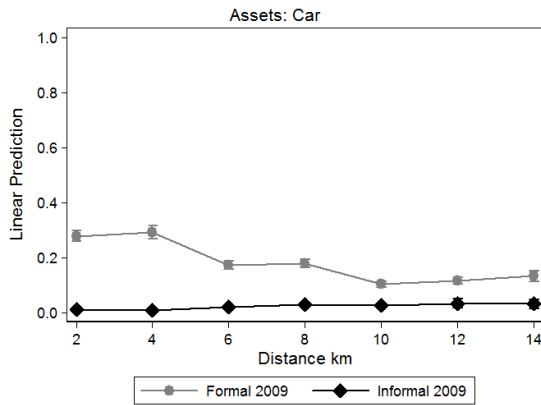


In Figure 8 we examine good ownership across space. Within formal areas, households nearer the CBD have higher rates of asset ownership. Among households in slums, this trend is reversed; households that are further from the CBD have a higher probability of owning a radio, TV, computer, bike, or fridge. This suggests a

trade-off between location and material wealth: living nearer to the centre is more costly and so, in choosing to do so, slum households may substitute away from buying other assets. The only good that does not follow this pattern is the mobile phone. While the probability of phone ownership varies across space, no clear pattern emerges. Together, the evidence suggests that those living in slums are materially wealthier than their rural counterparts, but that those in the central areas are materially poorer than those further out, which could either be due to lower incomes or to a trade-off between rents and asset ownership.

Figure 8: Variation in asset ownership according to distance from CBD





Note: Marginal effects of being in a slum or formal area in 1999 or 2009, estimated using OLS with 95 per cent confidence intervals and errors clustered at the EA level.

3. What does housing look like in slum areas?

- (a) *Slum housing is of poor quality, however some catch-up between slum and formal areas is observed over time.*
- (b) *This catch-up varies spatially, with improvements in building structures more likely further from the CBD.*
- (c) *There is little to suggest this varies according to ownership status. City residents are predominantly renters, both in slums and formal areas.*

Figure 9 documents how living in a slum area correlates with building quality in Nairobi. First, slums have distinctively worse building structures, particularly with regard to whether they have a solid wall, with only 26 per cent of households living in buildings with a solid wall versus 84 per cent in formal areas in 2009, and in terms of solid roofs, with 9 per cent of households in buildings with a tile or concrete roof compared to 45 per cent in formal areas. It is interesting to note that the differences are less striking for floor material, with a much higher proportion of slum households having cement or tile floors. Flooring is a cheaper and more flexible investment than the main structure of a building, so it may be easier for slum dwellers to invest in.

Over the preceding decade, slum areas experienced a greater increase in the likelihood of having a solid wall or floor compared to formal areas. There was a 4 percentage point rise in the likelihood of a household having a tile or concrete roof in slum areas and a 9 percentage point rise in stone or brick walls in slums — both double that seen in formal areas, as well as a 11 percentage point rise in cement or tile floors, over three times the rise seen in formal areas.⁵ When compared to levels in rural areas, in all three indicators housing in slums

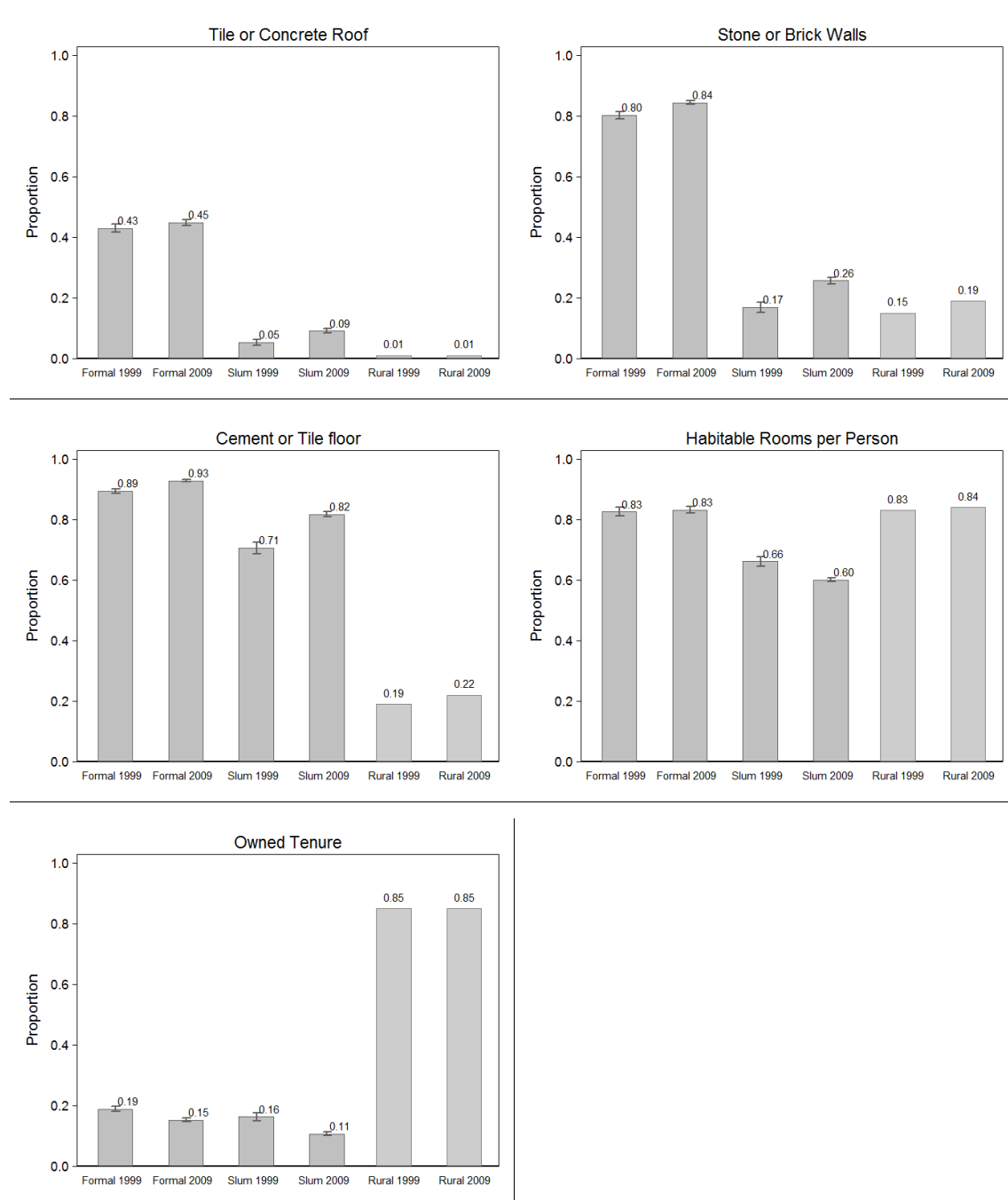
⁵ For studies that rely on satellite imagery to detect changes in slum areas, this point is important to note. The evidence suggests that improvements in housing structures are taking place, without a corresponding improvement in roof quality. Using roof changes to estimate investment in buildings may underestimate the effects.

is of higher quality than the average housing in rural areas, and has improved at a faster rate over the last 10 years.

Second, we note that slums are crowded, with 0.6 rooms per person compared to 0.83 on average in formal areas. While in formal areas the number of rooms per person has remained constant over time, it has decreased in slum areas. Combined with the poor quality housing and high population density, this results in lower liveability in slum areas. On this indicator, slums perform worse than rural areas.

We also observe that slum households are less likely to own the house they live in, though urban formal households are also very likely to be renters. In 2009, just over 10 per cent of slum households owned their own property, compared to over 15 per cent in formal areas, far below the levels in rural areas. This proportion has decreased over the last decade. The measure unfortunately does not capture the underlying land rights—for example, whether the owner has secure tenure. However as renters may have lower incentive to invest in their property and surroundings compared to permanent owners, it may reveal part of the story behind underinvestment in slums.

Figure 9: OLS sample means of building quality

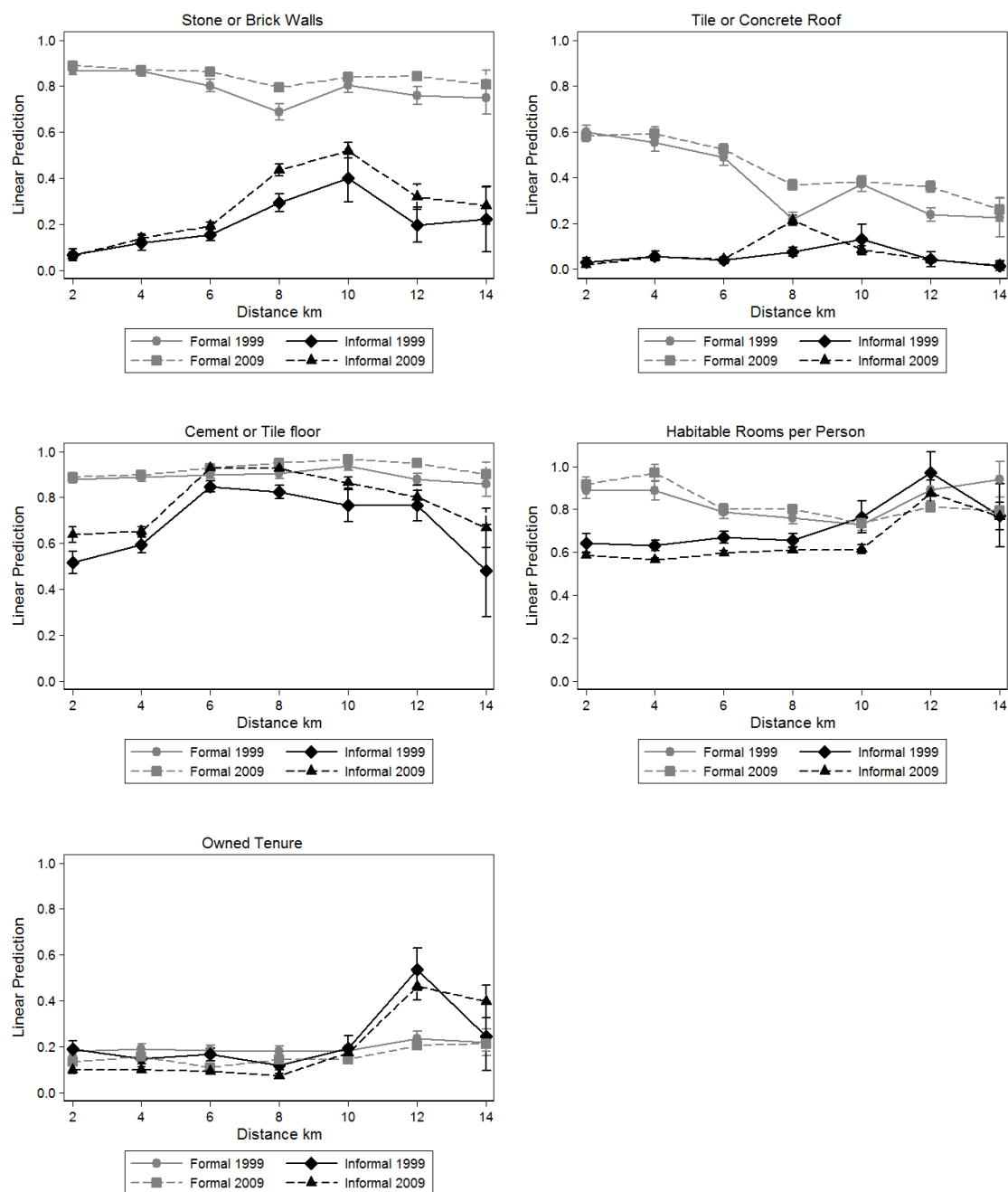


We then look to see how these levels and changes may vary according to the location of the slum. Figure 10 shows that the quality of buildings in slums is inferior to that in formal areas at all distances from the CBD. However, beyond approximately 7km from the centre the gap between formal and informal areas narrows. In terms of the size of the building, slums have on average 0.6 habitable rooms per person up until around 10km from the centre, at which point the space per person increases and falls in line with that seen in formal areas. This highlights a trade-off between living conditions and city access: poor quality housing and a lack of space defines slums in prime locations near the CBD, and higher-quality housing and more spacious properties are available further out. Consequently central slums appear visually to have particularly low living conditions. Interestingly, for formal areas this pattern is somewhat reversed, with more spacious housing and a higher proportion of houses with solid roofs near the centre.

Over time, while houses throughout the city have seen similar increases in the share with a solid cement or tile floor, improvements in the wall and roof structures have only occurred at these more distant locations. This suggests that more-distant slums are improving faster, perhaps because there is more space for new buildings, or because the land rights are such that it is easier to re-develop areas. Unfortunately, we cannot disentangle the tenure status within slums; however, in Figure 11 we examine how each of these characteristics varies according to the ownership status of the household. No clear pattern emerges, except that privately owned properties are larger. This differs from our priors, as we expected areas where the occupier has less security over their property to be areas of lower investment. However, as we cannot distinguish the ownership rights of the landlord, we do not know if there are varying effects according to the strength of the landlord's tenure security.

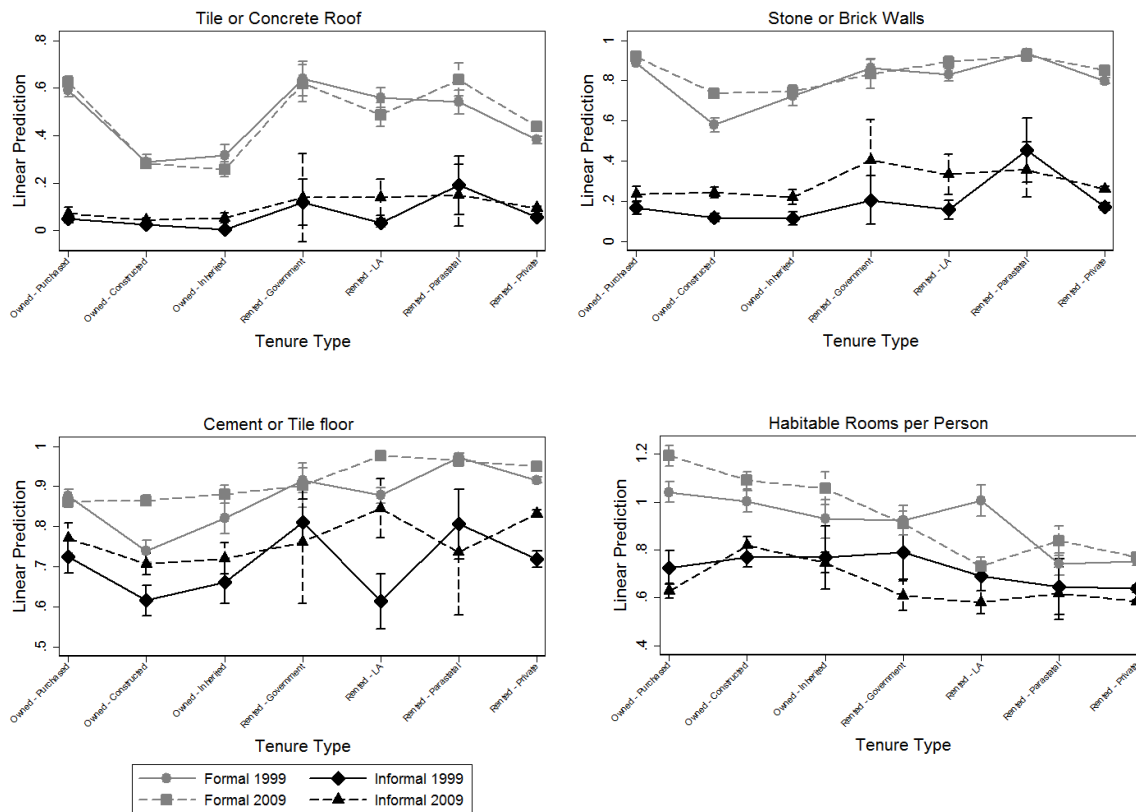
We also repeat the analysis looking at individual slums and observe substantial variation. Some slums have nearly no housing made from stone or brick walls, where as in others over 60 per cent of housing is. No clear patterns arise: some areas, such as Mukuru, have a low share of households with solid roofs or walls, but a high share with cement floors and others, such as Kayole, have a high share with solid walls, roofs, and floors, and larger properties than average, but have seen a large deterioration in each of these over the decade as the slums have grown and densified. This highlights the specificities of different slum areas. Various local characteristics including, but not limited to, location and tenure status will influence the development of slums and the investment in housing. Policy-makers both within Nairobi and beyond need to be aware of this local context.

Figure 10: Variation in building quality by distance to CBD



Note: Marginal effects of being in a slum or formal area in 1999 or 2009, estimated using OLS with 95 per cent confidence intervals and errors clustered at the EA level.

Figure 11: Variation in building quality by tenure status



Note: Marginal effects of being in a slum or formal area in 1999 or 2009, estimated using OLS with 95 per cent confidence intervals and errors clustered at the EA level.

4. How good is the access to services in slum areas?

- Slums have worse access to piped water, sewage systems, and electricity compared to other urban areas, but far higher rates than rural areas.*
- Improvements are noticed over time; however, for sewer systems, the rate of improvement is not enough to dramatically alter the gap between formal and informal areas.*
- Access to electricity in slums has improved, particularly electricity for lighting.*
- Variation across slums is large, but does not systematically correlate with the distance to the city centre.*

Figure 12 below shows the average rate of access to services in slum and formal areas, highlighting the differences in level of provision. While 83 per cent of formal households have access to piped water in 2009, and 78 per cent to improved sewage disposal, just 63 and 25 per cent, respectively, of slum households have such access. As outlined above, clean water supplies and proper sewage disposal are central to limiting the spread of contagious diseases and health outcomes. Small improvements in sewer access over time are present in slum areas, increasing by 7 percentage points compared to 4 percentage points in formal areas since 1999.

Unfortunately, the data do not permit intertemporal comparisons on piped water access. In rural areas, just 15 per cent of households have access to piped water and 1 per cent to sewers, showing that slums, while areas of service deprivation within the city, provide far better access to water and sanitation than rural housing.

We also note gaps in the use of electricity, particularly the low levels of electricity use for fuel in slums. The use of other fuels for cooking may impact local air quality and pollution in slum areas. The rate of improvement in access to electricity in slums is particularly striking. While in formal areas, the use of electricity or gas for fuel has risen by 10 percentage points, not far below the rate of increase for light of 15 percentage points, in slum areas the use of electricity or gas for fuel has risen just 4 percentage points in 10 years, compared to 28 percentage points for the use for light. This is consistent with a story of increasing availability of informal electricity supplies, with power sufficient for lighting but not for heating or cooking. Having access to lighting is beneficial to households by increasing the useful hours of the day for work and leisure time, but the limited increase in usage for fuel suggests these electricity networks are unsuitable to bring all the potential benefits of electricity. Anecdotal evidence suggests that local secondary electricity markets exist whereby a local seller connects to the grid and sells small amounts off to households through their own wiring system. Such a grid would have low capacity, consistent with our evidence showing higher electricity usage for lighting than for major household tasks such as cooking.

Figure 12: Mean access to services

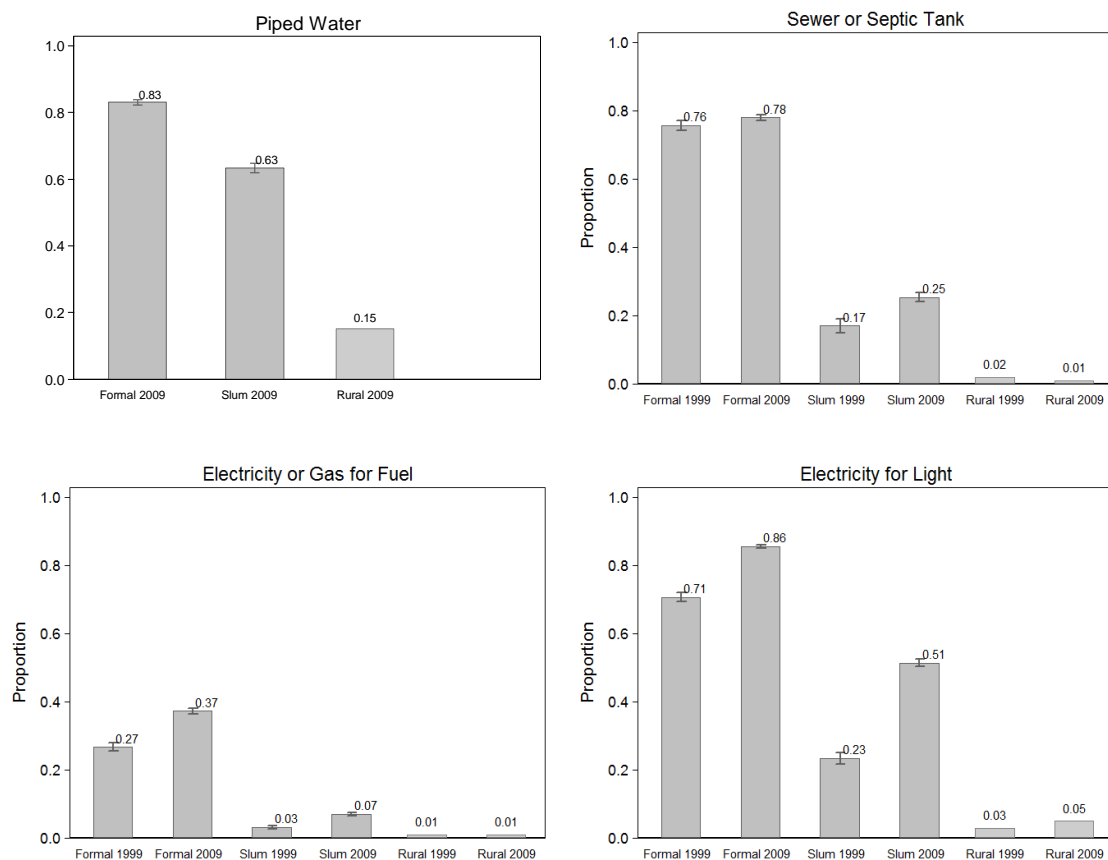
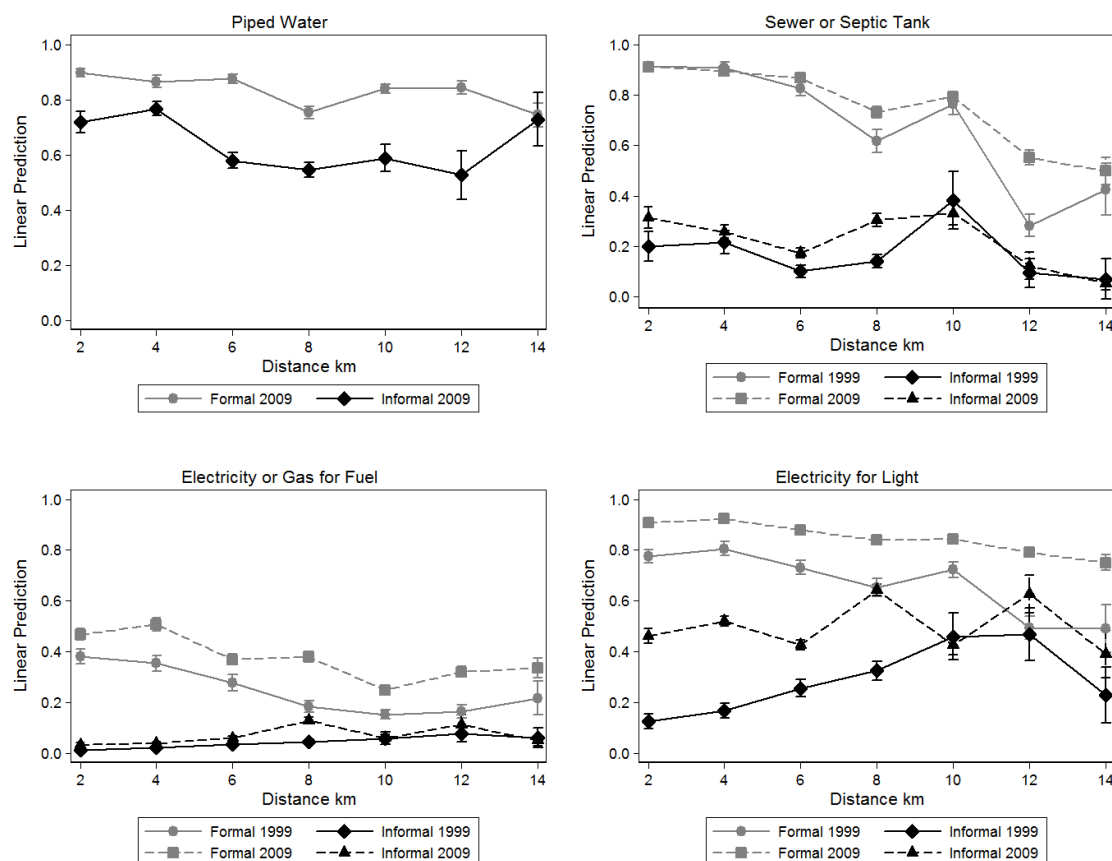


Figure 13 documents how this varies according to distance to the CBD. We note first that within slum areas access to piped water and sewers decreases with the distance. Access to electricity however does not. If the former require more government support to construct supply networks, this would suggest more attention historically has been placed on central slum areas. This could be due to higher population densities leading to increased cost-effectiveness for water provision, or because these areas are politically more sensitive, or because they are wealthier—unfortunately, a question we are unable to answer in this analysis. In terms of changes over time, we note that improvements occurred nearly uniformly throughout the distance bins. As these investments require some degree of coordination, one might expect that they are easier in denser, older slums near the CBD. Alternatively, one may also expect that it is easier to provide services in newer, less dense slums where there is space to construct new networks with less disruption. Neither of these two effects is dominating.

On a slum by slum basis, there is again substantial variation. Kayole, mentioned above to be the slum with the highest building quality but rapid decreases in this quality over time, has also seen some of the largest decreases in access to different services over the decade. The slum has grown and densified, and service provision has failed to keep up. Interestingly slums, such as Uthuru, that have high levels of access to piped water do not always have good sanitation, and similarly slums with improvements in sanitation services are not the same slums that have seen improvements in electricity access. Again, this highlights the importance of the local circumstances in understanding the provision, or lack of provision, of key local services.

Figure 13: Variation in access to services by distance to centre



Note: Marginal effects of being in a slum or formal area in 1999 or 2009, estimated using OLS with 95 per cent confidence intervals and errors clustered at the EA level.

5. How well are children doing in slums?

- School attendance rates have increased and converged across formal and slum areas.*
- These effects occurred throughout the city, ensuring all areas have similar access to primary schooling and higher access than in rural areas.*
- Child mortality remains higher in slum areas, but again substantial gains have been made. The rate of child mortality varies substantially by slum.*

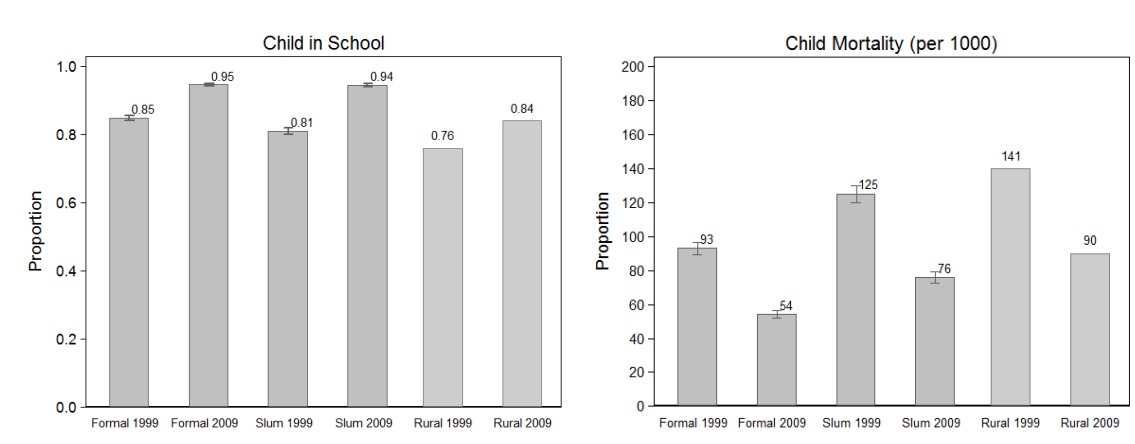
Figure 14 shows that the levels of child school attendance are nearly identical across slum and formal areas in 2009, but that child mortality remains higher in informal settlements, at 76 children per thousand vs 54 children per thousand in formal areas.⁶ Both of these measures show considerable catch-up over time and, when compared to rural areas: 94 per cent of children attend school in slum areas compared to 84 per cent in rural areas today. The increase in access to schooling is likely to be at least in part attributable to the Free

⁶ Note that child mortality is calculated using the number of child deaths per live births, without any age threshold. This makes it not comparable to standard measures that set, for example, a threshold at 5 years of age.

Primary Education Programme, brought in during the early 2000s midway between our two census rounds, which offered all primary-age children free schooling. Previously, school fees had been a major barrier to entry to education (Glennerster *et al.* 2011), but the removal of this cost has led to near universal primary education. The lower levels in rural areas are likely due to access issues; within a dense urban environment, the nearest school is typically closer than it would be in a rural area. Unfortunately, nothing can be said about the quality of this education. From Figure 15 we observe that this impact was felt throughout the city; no matter where a child is living in the city there is near universal access.

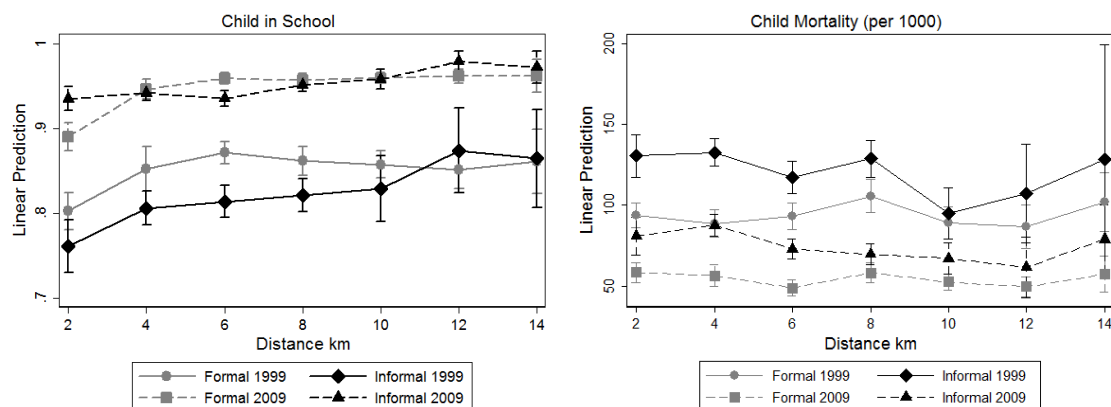
In terms of child mortality, slum areas have also seen substantial catch-up. Slums have reached levels throughout the city in 2009 that are lower than those seen in formal areas just 10 years previously. However, a gap still remains. The improvements in child mortality vary wildly between slums, suggesting different local forces are at play here. In part, this may be explained by the lack of services, such as water and sewer systems, as discussed above. Figure 15 shows child mortality is higher in more central areas, areas which we have already shown to be dense and with poor-quality buildings, both factors in the rate of spread of disease.

Figure 16: Mean child health and education outcomes



Notes: Note that child mortality is calculated as children lost from 1,000 live births, with no limit in age at which the child may have died, and is therefore not comparable to the standard definition with a 5-year threshold.

Figure 17a–b: Variation in outcomes by distance to centre



Note: Marginal effects of being in a slum or formal area in 1999 or 2009, estimated using OLS with 95 per cent confidence intervals and errors clustered at the EA level.

V. Discussion and conclusion

The stylized facts above reveal slums to differ vastly from more formal areas within the city of Nairobi. Some of these characteristics are true across all slum areas, be it that slum residents are less well educated, live in smaller spaces, and that their housing is of lower quality and has poorer access to services such as water and electricity. However, looking more deeply at the data we observe that there is variation across space, and across specific slums. The variation across space highlights the issue of using local surveys to draw general conclusions on slums, as the current conditions in slums and the pace and direction of change over time are both very localized. Some of these trends appear to vary in a consistent spatial way, such as that those living in more central slums are 15 percentage points more likely to be in paid employment than those on the urban fringes. Other variations are not explained by the data and therefore must be assumed to depend on other local characteristics, such as land tenure, security, political will, or proximity to certain urban services such as health clinics or NGOs. What we learn from one slum need not apply to another, and evidence from slums in Nairobi need not necessarily apply to slums throughout the East African region or beyond.

We can, however, draw out some conclusions from these Nairobi facts, and some questions that require further investigation. First, slums are difficult places to live, with density in some slums ten times that in neighbouring formal areas, low levels of space per person, poor building quality, and poor access to services. Yet compared to rural areas, on many of these dimensions individuals living in slums are actually faced with better conditions. Second, slums are changing, both in terms of demographics and buildings and services. Between

1999 and 2009 individuals in slums became 11 per cent more likely to have a secondary education, a trend observed throughout the city, thereby suggesting this is not just a story of the poorly educated being displaced from living in slums. Simultaneously, buildings in slums improved, particularly in terms of the wall and floor quality, investments which have substantial effects on living conditions. Access to electricity, and to a lesser extent sanitation, also rose. These improvements occurred faster than in rural Kenya. Third, the size of these changes vary by location of the slum and, in particular, central slums have different dynamics to more distant slums. In central slum areas, households have fewer assets, and rents are expected to be higher as the land provides greater access to services and jobs. Density is high and the number of rooms per person is low, and, in turn, improvements in building quality over time are limited. This gives an appearance of central slums being areas stuck in poverty. We cannot disentangle the reasons behind this slow progress, be it due to the lack of space or land tenure issues (though it is not correlated with a lower share of owner-occupiers) or political issues as discussed above. However, in central slums a higher share of residents are also in paid employment, indicating that there is a trade-off between better quality living conditions and better access to urban opportunities. Fourth, despite these differences in dynamics, socio-economic indicators for children have improved throughout the city. Access to schooling in slum areas has caught up with the levels seen in other areas, and child mortality has fallen substantially. Together these facts show how slums can still be seen as places where people choose to live, despite appearances, at least compared to rural areas. In particular, living in slum areas provides better opportunities for children, and the potential for improving living conditions over time.

For policy-makers it is also important to underline what we cannot show, opening avenues into further research and allowing those invested in improving urban living conditions to be aware of the main caveats of this analysis. First, we cannot disprove from this the existence of any local poverty traps, but we can show that within slums there is the potential for development over time. For buildings and services, the reasons behind the slow improvements in central areas could be further investigated. Second, we also cannot rule out the idea that slums are inefficient use of land. They are providing accommodation for hundreds of thousands of urban residents in cheap housing; however, there are frictions in the allocation of this land and we do not know if this is preventing it from being put to a higher value use. Third, we show large variation across slums in the levels of investment in private buildings and public services. Some of this variation is explained by the location of the slum but not all, and here the local context is of high importance. What is important to note is that for services that can be accessed through private investment, such as access to electricity for lighting, we have seen a large increase in provision. For services that require public investment or at least coordination between numerous households, such as sanitation, the improvements have been slower. Policy-makers should take note of the difficulties for local communities to set-up such systems, and work to enable research and policy to support further improvements in this direction.

Finally, observing centrally located slums may give a sense of slums as areas of deprivation, with poor-quality buildings not changing over time while density rises. But the evidence suggests that these areas are more dynamic than first appearances. Internal investment in buildings is occurring, despite constraints on more substantial structural improvements; what can be done to support the latter as well as the former? Access to electricity is rising through likely private investments; can public services in slums be structured in a way that allows for similar improvements over the next decade? And child socio-economic outcomes are improving, with near universal school attendance following the introduction of free schooling; can similar strategies be used to bring child mortality down further?

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